

IGNITION, TWO POINT SYSTEM

MERITS OF THIS SCHEME ARE OUTLINED.

Greater Number of Particles of Mixture Is More Rapidly Ignited by the Two Plugs and There Is Correspondingly Less Loss Power in the Explosion.

A talk on ignition and ignition methods given by Roger B. Whitman of the Bosch Magneto Company not long ago before the Long Island Automobile Club developed the merits claimed for the two point system. Mr. Whitman dealt with the details of ignition and its method. His paper is given almost in its entirety below.

The state of perfection of the present day internal combustion engine has not been reached without deep study and investigation, in the course of which it has been realized that ignition has vastly more to do with efficiency than was at first believed.

The early conception of ignition was the production of a spark some time toward the end of the compression stroke, and if this spark was successful in igniting the mixture that was all that was desired. The character of the spark, its location, its production, or the exactness of its timing were points that were disregarded by the designer, because he did not understand that these had any bearing on the power output or on the fuel consumption of the engine.

The modern designer takes an entirely different view of the subject, however, and it may be of interest to outline the problem as it is now understood.

To appreciate the fine points of ignition as they are understood today the engine must be considered in its true light as a heat engine pure and simple.

The mixture that is drawn into the cylinder during the inlet stroke represents a certain heat value, and the efficiency of the engine depends upon the manner in which this heat is applied to the expansion of the gases. Any condition by which some of this heat is lost or by which it is not applied directly to the forcing of the piston upward on the power stroke will reduce engine efficiency.

The first step in the securing of efficiency will be to study the points at which losses of heat may occur and to adopt means by which these losses may be prevented.

The charge of mixture represents a certain heat value and has a certain amount of pressure. To exert the greatest possible proportion of this pressure against the piston each particle of mixture should be made to give up its heat at the instant when the piston is at the end of the compression stroke and ready to move upward on the power stroke.

To gain this result it would be necessary to ignite each particle of the mixture at the same instant, and thus to have ignition and combustion occur at top dead center. The mixture would thus be compressed into a minimum space before ignition, and the rise in pressure due to combustion would then be most abrupt, the piston being driven outward with maximum force.

No existing ignition system will permit the ignition of all of the particles of mixture at the same instant. The system in use therefore permits ignition of the mixture at one or two points from which the flame is expected to communicate itself to the remaining mixture particles.

In a perfect mixture each particle of gasoline vapor will be surrounded by air, and to ignite the mixture it will be necessary to raise the temperature of these particles to the point at which the chemical change known as combustion will occur.

Under usual motor conditions the heat developed by the electric spark is depended upon to raise the temperature of certain of these particles to the point at which they will ignite, and the flame thus started is communicated to the particles of the mixture immediately surrounding it, this being propagated throughout the entire charge.

To our senses the spread of the flame from the point of ignition is instantaneous, but in comparison with the speed at which a gasoline engine operates the time required is very considerable and must be taken into consideration. Thus there enters into our calculations the period of time that must elapse between the instant at which ignition occurs and the instant at which the entire charge will be inflamed.

We desire to apply to the piston the greatest pressure possible, and obviously the greatest possible pressure will be produced at the instant when combustion is complete. At this instant, therefore, the piston should be at the top of its stroke. We must not overlook the fact, however, that some pressure is produced at the instant when ignition occurs and that this pressure will be constantly increasing as combustion spreads. If combustion is to be complete when the piston is at its top position it is clear that ignition must occur while the piston is still moving upward on the compression stroke. For the last portion of its stroke the piston will therefore be subjected to this pressure, which is rising to maximum, and by which the piston will tend to be driven backward at the same time the momentum of the flywheel is urging the piston upward. Some of the power of the engine will thus be required to force the piston upward, and in this is found one of the most serious of the losses in engine efficiency.

If the engine is going at a sufficient speed the momentum of the flywheel will force the piston against the pressure in the combustion space to top center, but the result of the conflicting pressures will be shown in abnormal wear of the wrist pin, crank pin and main bearings.

You have all had experience with a back fire when cranking an engine and know that it is the production of maximum pressure in the combustion space before the piston reaches the top of its stroke, the result being that the engine starts to run backward. This same condition in a lesser degree exists in a running engine under the normal condition of ignition occurring before top center.

A charge of mixture represents a certain heat value and can be made to exert a certain definite pressure upon the piston. To get the best possible results all of this pressure should be exerted against the piston when the latter is at the top of its stroke. If some of the pressure is exerted before the top center is reached less pressure will, of course, remain to act on the piston during the power stroke. This entails a double loss, for not only is the rotation of the crank shaft somewhat retarded but the maximum pressure is developed at top center in the consumption of fuel and in a reduction of the power output.

Another loss that results from ignition earlier in the stroke is due to the absorption of heat by the cylinder walls and these surfaces being of metallic nature natural conductors

of heat, and of course the longer the period during which the flame is in contact with these surfaces the greater will be the heat absorbed and wasted in this manner.

The obvious way to reduce loss of power from these causes is to produce ignition as late in the stroke as possible, but in this we are limited by the necessity for having combustion complete at top center.

The remedy will therefore be to hasten ignition as much as possible, or in other words to reduce the time necessary for the propagation of the flame throughout the combustion space.

One of the most important factors in this is the location of the spark plug, which should be placed in such a position that the flame must spread as far as possible. If, for instance, the plug is located in the inlet valve cap the distance through which the flame must spread will be practically maximum, and the operation will require more time than would be necessary if the spark plug were located in the cylinder head. Further more, the plug should be so located that its points are actually plunged in the mixture and not set in a cavity or pocket. Engines are occasionally seen with valve caps that are solid and possibly an inch thick. If a standard plug is screwed into such a cap the spark points will be four or five inches from the hole, and the distance through which the flame will have to travel will be correspondingly increased.

The size of the ignition spark is also a factor that determines the time required for the flame to travel through the combustion space. The spark should be of a mass of flame with as large a surface as possible, for this will result in a large number of particles of mixture particles. It should be understood that the spark must come into actual contact with the mixture particles in order to ignite them, and if the spark is thin it will be quite impossible for it to pass through a mass of mixture particles. The time required for the flame to travel through the combustion space will be correspondingly increased.

With a spark that is in the nature of a flame mass, however, the flame will spread not only in the combustion space but also in the inlet and exhaust valves, and sparks are caused to occur at these points at the same instant that they occur in the combustion space.

The spread of the flame throughout the whole charge will be much less than would be the case if the flame were to originate at one side and be required to spread across the entire width of the combustion space.

It has been admitted that the flame must travel a long time, but the difficulty in its practical application lay in the securing of a spark that would permit the production of two sparks at absolutely the same instant.

The ignition apparatus of this character has now been perfected, however, with results that are satisfactory from every point of view. The mixture is now ignited by a single spark that is in the nature of a flame mass, and it is essential to locate the spark plug properly. If the two are set side by side in the inlet valve cap, for instance, there will be no gain through the use of two spark ignition over one spark. To secure proper results from this system it is necessary to separate the plugs and to locate them so that the flame will have an opportunity to spread in all directions from each.

A series of comparative tests was recently made on an engine arranged for operation either with one spark or with two. The engine was a four cylinder 3-8 inch motor, and the results were as follows: With one spark the maximum power output was 18 per cent.

With single spark ignition the maximum output of 24 horse-power was reached with a 30 degree advance, and with two spark ignition the same output of 24 horse-power was obtained with an advance of 28 degrees. In other words, the maximum power output possible with single spark ignition was equalled by two spark ignition at considerably less than one-half the advance, while with two spark ignition it was possible to increase the maximum power output by 18 per cent.

At first sight it seems somewhat extraordinary to claim that the power output of an engine will be increased 18 per cent or more by the use of two spark ignition in the cylinder instead of one, but the line of reasoning that we have followed makes it clear that this is a fact, and the actual results that we have followed in the case of the engine under test confirm this claim.

The two spark ignition system has been used on racing cars since last fall, the Vanderbilt race marking its first appearance on American roads. In that race Devoson's Marmon car was equipped with a Bosch magneto of the two spark ignition type, and no one who saw it run could fail to be impressed with its extreme speed and its extraordinary ability to pick up after a slowdown.

All cars entered in races subsequent to the Vanderbilt have been equipped with two spark ignition, and it is now a question of actual results it may be said that the Marmon and Lozier cars showed an actual increase in speed of from four to five miles an hour on changing from single to two spark ignition.

This system unquestionably marks the greatest improvement that has been made in engine operation for a number of years past. The system is of great simplicity, for it is identical with the ordinary magneto, except that a second distributor is provided in the magneto of the independent type one end of the armature winding is grounded on the armature core, and the other end is grounded on the distributor. The second spark plug returns to the grounded end of the winding instead of being grounded on the armature core as is carried out through the distributor and grounded on the engine.

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ignition current in the secondary winding. It is this current that furnishes the spark. It is seen that the electric current is required to do certain work, and the closing of the circuit of the coil, and the production of the spark at the plug, and the lack of accuracy in the system, have in the past caused the current to do more work than the same time in performing these functions.

This can be demonstrated on apparatus that consists of a shaft that may be driven at variable speed by an electric motor. This shaft carries a pointer that travels around the inner side of a graduated ring, while the other end of the shaft carries a battery magnet, the magnet armature and the timer revolving at the same rate as the pointer and the graduated ring. The spark produced by the magnet or by the coil may be caused to pass between the moving pointer and the graduated ring.

Turning the apparatus slowly by hand with the magnet thrown into the circuit will show that the spark is produced at the zero point of the graduation. By throwing in the electric motor the speed of the magnet is increased to about 1,500 revolutions a minute and it will be seen that the magnet spark invariably occurs at the same point.

In other words the point in the rotation of the shaft at which the magnet spark occurs is not affected by the speed of the magnet. As the speed increases the igniting ability of the spark evidently increases, for it can be seen to increase until 1,500 revolutions a minute it endures for about 20 degrees of rotation.

Turning the magnet out of circuit and cutting in the battery, we will again turn the apparatus slowly by hand. The first spark will be seen to appear at the zero point, and at low speed there is an apparent sheet of flame for the entire 40 degrees during which the timer is in contact.

Running the speed up slightly, we will see that this sheet of flame is broken up into a series of single sparks, which occur very closely together. Throwing in the electric motor, we will see that at 200 revolutions a minute the distance between the successive sparks is increased very considerably.

Each of these sparks corresponds to a single movement of the vibrator, during which the battery circuit through the primary winding of the coil is closed.

We will see another interesting thing, which is that the first spark no longer occurs at the zero point, but is shifted toward the right. On increasing the speed to 1,000 and then to 1,500 revolutions we will finally find that during the entire 40 degrees of the timer making contact, only two sparks are produced, which means of course that during that period of time the vibrator has time to move but twice.

The vibrator will make a certain number of vibrations a second, say 30, if the coil holds its circuit closed for one second there will be of course 30 sparks produced at the pointer. If on the other hand the timer holds the circuit closed for but 1-10th of a second there will be time for but three vibrations, and consequently only three sparks will be produced. Furthermore, the first spark, instead of occurring at the zero point, appears some 20 or 25 degrees afterward, and we immediately recognize this lag as representing the time required for the current to perform its various functions between the instant when the timer closes the circuit and the instant when the spark appears.

The delay in the production of the spark may be corrected by every means so that contact is made some little time before the spark is actually required. The lag due to the work of the vibrator must perform is thus overcome mechanically by moving the timer.

The moving of the timer, however, does not correct the shifting in the position of the spark, and this cannot be corrected by any means that could be used on an automobile.

If the spark is observed it will be seen that it does not occur at the zero point, but varies considerably, the total variation being 8 or 10 degrees.

At the instant when the timer closes the circuit the vibrator contact may also be closed; but on the other hand, the vibrator contact may be open when the timer closes the circuit, and the voltage of the battery will also cause a difference, for the lower the voltage the less able will the primary circuit be to force itself through the winding of the coil.

The coil offers resistance, of course, and it takes certain time to overcome it, and the pressure must be increased, or in other words the voltage in the battery must be raised.

If we could change the voltage of the battery to correspond with every variation in the speed of the engine we might get better results, but we would still need a vibrator blade that would be able to follow the actual and good contact every time the timer closes the circuit. Furthermore, we would find it necessary to ensure ourselves that the circuit was actually closed at the timer, for when the timer contacts are covered with grease or dirt the circuit will not be actually closed until the moving part of the timer is half way across the timer contacts.

The timer that is used with the testing apparatus is operating under perfect conditions and the contacts are clean and uncorroded. This is not often the case with the timers that are used on automobiles, and consequently the lag due to the timer is such apparatus on an automobile are far worse than are here indicated.

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One thing that did much to give the Cole cars a strong bonus in the victory in the Massachusetts sweepstakes in connection with the Vanderbilt cup races, J. J. Cole, president of the Cole Motor Car Company, is a former carriage manufacturer. He is a strong believer in racing.

"I firmly believe that a race track should be adjacent to every automobile factory," says he. "Each car should be tested out before it is finally delivered to the customer. By this I mean that a competent mechanic should give the motor a good shaking up, and that the car should be taken for a test run on a test clip and then looked over. In Indianapolis all of the automobile manufacturers have their cars taken for a test run. We all agree that this is a good thing."

The automobile manufacturer's responsibility does not stop when the car leaves his factory. If there is an accident and it can be traced to faulty mechanism, it is the manufacturer's indirectly to blame.

HAYNES FANT REBUILDING.

Factory Going Up In Good Shape and Prospects Are Bright.

E. W. Headington, manager of the local Haynes branch, returned not long ago from a visit to the factory at Kokomo with this report:

"Work is well under way on the new Haynes factory, a modern concrete and steel structure being erected, which will be completed within a few months. The new building will be more than double the floor space of the old factory. New machinery and equipment have already commenced to arrive and by June 15 the entire plant will be completed and cars be produced."

While the new plant is under construction work is being carried on in temporary quarters and our 1911 season's output will not be interrupted in any way.

At the present time this office is receiving ten cars a week which are being delivered as fast as received. We anticipate one of the best business seasons we have ever had."

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ignition current in the secondary winding. It is this current that furnishes the spark. It is seen that the electric current is required to do certain work, and the closing of the circuit of the coil, and the production of the spark at the plug, and the lack of accuracy in the system, have in the past caused the current to do more work than the same time in performing these functions.

This can be demonstrated on apparatus that consists of a shaft that may be driven at variable speed by an electric motor. This shaft carries a pointer that travels around the inner side of a graduated ring, while the other end of the shaft carries a battery magnet, the magnet armature and the timer revolving at the same rate as the pointer and the graduated ring. The spark produced by the magnet or by the coil may be caused to pass between the moving pointer and the graduated ring.

Turning the apparatus slowly by hand with the magnet thrown into the circuit will show that the spark is produced at the zero point of the graduation. By throwing in the electric motor the speed of the magnet is increased to about 1,500 revolutions a minute and it will be seen that the magnet spark invariably occurs at the same point.

In other words the point in the rotation of the shaft at which the magnet spark occurs is not affected by the speed of the magnet. As the speed increases the igniting ability of the spark evidently increases, for it can be seen to increase until 1,500 revolutions a minute it endures for about 20 degrees of rotation.

Turning the magnet out of circuit and cutting in the battery, we will again turn the apparatus slowly by hand. The first spark will be seen to appear at the zero point, and at low speed there is an apparent sheet of flame for the entire 40 degrees during which the timer is in contact.

Running the speed up slightly, we will see that this sheet of flame is broken up into a series of single sparks, which occur very closely together. Throwing in the electric motor, we will see that at 200 revolutions a minute the distance between the successive sparks is increased very considerably.

Each of these sparks corresponds to a single movement of the vibrator, during which the battery circuit through the primary winding of the coil is closed.

We will see another interesting thing, which is that the first spark no longer occurs at the zero point, but is shifted toward the right. On increasing the speed to 1,000 and then to 1,500 revolutions we will finally find that during the entire 40 degrees of the timer making contact, only two sparks are produced, which means of course that during that period of time the vibrator has time to move but twice.

The vibrator will make a certain number of vibrations a second, say 30, if the coil holds its circuit closed for one second there will be of course 30 sparks produced at the pointer. If on the other hand the timer holds the circuit closed for but 1-10th of a second there will be time for but three vibrations, and consequently only three sparks will be produced. Furthermore, the first spark, instead of occurring at the zero point, appears some 20 or 25 degrees afterward, and we immediately recognize this lag as representing the time required for the current to perform its various functions between the instant when the timer closes the circuit and the instant when the spark appears.

The delay in the production of the spark may be corrected by every means so that contact is made some little time before the spark is actually required. The lag due to the work of the vibrator must perform is thus overcome mechanically by moving the timer.

The moving of the timer, however, does not correct the shifting in the position of the spark, and this cannot be corrected by any means that could be used on an automobile.

If the spark is observed it will be seen that it does not occur at the zero point, but varies considerably, the total variation being 8 or 10 degrees.

At the instant when the timer closes the circuit the vibrator contact may also be closed; but on the other hand, the vibrator contact may be open when the timer closes the circuit, and the voltage of the battery will also cause a difference, for the lower the voltage the less able will the primary circuit be to force itself through the winding of the coil.

The coil offers resistance, of course, and it takes certain time to overcome it, and the pressure must be increased, or in other words the voltage in the battery must be raised.

If we could change the voltage of the battery to correspond with every variation in the speed of the engine we might get better results, but we would still need a vibrator blade that would be able to follow the actual and good contact every time the timer closes the circuit. Furthermore, we would find it necessary to ensure ourselves that the circuit was actually closed at the timer, for when the timer contacts are covered with grease or dirt the circuit will not be actually closed until the moving part of the timer is half way across the timer contacts.

The timer that is used with the testing apparatus is operating under perfect conditions and the contacts are clean and uncorroded. This is not often the case with the timers that are used on automobiles, and consequently the lag due to the timer is such apparatus on an automobile are far worse than are here indicated.

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